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The glycaemic index of Manuka honey

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SUMMARY

Background & aims: Rates of obesity and diabetes are increasing in Western populations, and it is suggested that these diseases can be moderated, in part, by consuming foods that produce a low blood sugar response. Anecdotally honeys are thought to be comparable to simple sugars for sweetness and glycaemic response, although little is currently known about the medically beneficial Manuka honey from New Zealand. The aim of this study was to measure the glycaemic index (GI) of five samples of Manuka honey from different geographic origins.
Methods: Five high methylglyoxal (460–667 mg/kg) Manuka honey samples were selected from different geographical locales around the North Island of NZ and tested for GI in 10 healthy volunteers in a single-blinded, randomised study. Participants were fed honey containing 25 g of available carbohydrate in 200 ml water and the blood glucose responses measured (incremental area under the curve; IAUC) and compared to that of 25 g of available carbohydrate from glucose.
Results: All five honey samples were shown to have moderate GI values (54–59), although variation amongst the group was high.
Conclusions: The GI of five Manuka honeys tested was in the moderate range, being 54–59.
This study is registered under Clinical Trials.gov Identifier number NCT01615588.

1. Introduction

Manuka honey is produced by introduced European honey bees (*Apis mellifera*) feeding on the Manuka tree (*Leptospermum scoparium*), which grows throughout New Zealand. Consumed for literally thousands of years, and believed historically by many cultures to possess healing properties, honeys from certain floral sources are now gaining recognition for their potential health benefits. Manuka Honey, for example, has been shown to have high levels of the bioactive compound methylglyoxal[1] and as a result Manuka honey is now well accepted in the literature for its positive effects on health and wellness (including antimicrobial, anti-inflammatory, immunostimulatory activities and wound healing capabilities).[2,3]

The World Health Organisation (WHO) has reported the global prevalence of obesity/overweight has doubled since 1980[4] and predict that rates of diabetes related death will double between 2005 and 2030.[5] It is strongly recommended by the Public Health arm of the World Health Organisation to actively promote blood glucose control, an intervention that is achievable in both developing and developed countries.[5] Data shows that there are strong correlations between consumption of high glycaemic index (GI) foods and increased weight gain, and that low GI foods can be beneficial for weight management and weight loss.[6] Importantly, there are a number of studies that also show that the blood glucose response of honey is actually lower than comparable amounts of pure sugar[7-9] despite the fact that amount of total carbohydrate in honey and pure sugar is similar (approximately 80% of the solids in honey are sugars).[10] Furthermore, other studies have reported that consumption of honey leads to a greater elevation of insulin, and lower blood glucose levels compared with glucose syrup.[2,11,12] It has been suggested that this could be due to the fact that honey contains a large number of enzymes, vitamins, flavonoids, phenolic and organic compounds.[2,13]

Currently there is minimal data available for the GI value is of Manuka honey as only one sample has previously been tested.[14] However, given the interest in the medical and health-promoting properties of Manuka honey, as well as the extensive composition of different honeys, the GI properties of Manuka honey warrant investigation.

2. Methods

2.1. Glycaemic index testing protocol

The protocol used to determine the GI value of the Manuka honey samples follows the International Organization for

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Standardization ISO 26642:2010(E) for the determination of the glycaemic index (GI)[15] The study undertaken was single-blinded and all samples (including glucose) were randomised throughout the six testing sessions. All six testing sessions were completed within a two-week period (Monday, Wednesday and Friday of both weeks).

2.2. Participants

The Waiariki Institute of Technology Research Ethics Committee approved this study for GI testing, and written informed consent was obtained from all 10 volunteers (8 female and 2 male). The mean age of the study group was 28.4 years (range 24–44 years). Height and weight were measured by the Waiariki Occupational Health nurse and used to calculated Body Mass Index (BMI). The mean BMI of the study group was 22.6 kg/m^2 (range 19.5–26.5 kg/m^2). Screening criteria included healthy individuals with no food allergies, diabetes or chronic illness, and who were not taking any medications. These screening methods are in line with standard GI testing criteria.[7]

2.3. Test meals

2.3.1. Reference glucose

The reference solution was 25 g of D-glucose anhydrous (Hansells (New Zealand) Ltd). A sample size of 27.5 g was required to deliver 25 g of available carbohydrate in 200 ml of water.

2.3.2. Test foods

Samples of unprocessed Manuka honey were selected from different geographical regions of New Zealand. The honeys were tested for methylglyoxal levels (as an indicator of them being pure Manuka rather than a Manuka/Kanuka blend) by HPLC using the method outlined by Mavric et al. (2008).[1] Five honeys with a methylglyoxal level of at least 450 mg/kg were selected (see Table 1). Each serving of honey was prepared to contain 25 g of available carbohydrate.

Each sample was mixed into 200 ml of water before consuming. Lids were placed on the cups before giving them to the participants so that they could not easily distinguish what they were drinking.

2.4. Calculation of portion size of the honey products

Available carbohydrate was determined by Asure Quality NZ Ltd using gas chromatography as described by the Australia New Zealand Food Authority (1992).[16] Portion size was determined by calculating what weight of honey was required to provide 25 g of available carbohydrate. This information is given in Table 1.

2.5. Blood glucose testing and analyses

The volunteers attended the clinic at 08:00 h for testing after a 10-h overnight fast. A fasting blood sample was collected by capillary blood sampling via finger prick within five minutes, and the value taken as the baseline blood glucose concentration. Participants consumed the test sample within five minutes after the baseline sample had been collected. Further blood samples were taken at 15, 30, 45, 60, 90, and 120 min respectively from the initial time of consumption. Capillary blood was analysed immediately for blood glucose concentration using a calibrated Accu-Chek Performa blood glucose meter (Roche Diagnostics, Germany).

2.6. Measurement of glycaemic index

Glycaemic index was determined using a method based upon that of Wolever and Jenkins (1986).[17] This involves calculating the incremental area under the blood glucose response curve (IAUC) of a 25 g carbohydrate portion of a test food and expressing it as a percent of the response to 25 g of carbohydrate from the reference food (glucose) taken by the same participant. The area under the curve was determined as the area of those increments above baseline only. This, and statistical mean comparison (ANOVA) between samples was determined using NCSS (Statistics Analysis and Graphics) 2007 software.

2.7. Sugar profiles

Sugar Profiles of the five chosen Manuka honeys were analysed by Asure Quality NZ Ltd using Gas Chromatography with Flame Ionisation Detection as detailed by the Australia New Zealand Food Authority (1992).[18] These results are shown in Table 2.

Table 2
Sugar profile information.

Sample		Sucrose (%)	Fructose (%)	Glucose (%)	Maltose (%)	Lactose (anhydrous (%)
1	WINPDW 60-11	<0.1	40.4	31.9	3.0	<0.1
2	BR15-11-154	<0.1	39.9	31.8	3.6	<0.1
3	PORD3-11	<0.1	39.9	34.3	1.8	<0.1
4	MED WM38-10	<0.1	40.4	32.5	2.7	<0.1
5	M75-11	<0.1	38.5	35.2	2.3	<0.1

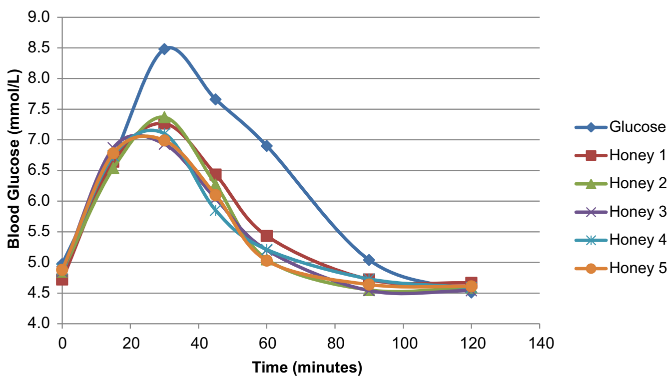
3. Results

The mean blood glucose responses for glucose and the five honey samples are given in Fig. 1. Glucose generated the largest increase in blood glucose levels. All five Manuka honey samples demonstrated blood glucose curves that were similar to each other, and all samples (including glucose) had a mean blood glucose level peak at 30 minutes.

GI values for the five honey samples are given in Table 3. IAUC data from most participants was lower for the honey samples compared with the glucose standard; however, one participant showed increased IAUCs with honeys 1, 2, and 3 compared to the glucose. Similarly, a second participant showed an IAUC of more

Table 1
Sample information.

Sample		Region	Methylglyoxal level (mg/kg)	Available carbohydrate (%; g/100 g)	Weight required to deliver 25 g available carbohydrate (g)
1	WINPDW 60-11	Northland	460	77.9	32.1
2	BR15-11-154	Levin	571	76.5	32.7
3	PORD3-11	Central North Island	569	77.5	32.3
4	MED WM38-10	Wairarapa	666	78.0	32.1
5	M75-11	East Cape	667	77.9	32.1
6	Glucose		na	91.0	27.5



*n=9 for honey # 3

Fig. 1. Mean incremental blood glucose response of the five honey samples versus a glucose reference in healthy participants ($n = 10$)*. *$n = 9$ for honey #3.

than 100 for Honey 3. All data were included in the results, but values that lay more than two standard deviations away from the mean were excluded from the final calculations of GI values as suggested by Perry et al., 2011.[14]

Results of the present study demonstrate that the Manuka honeys tested are all moderate glycaemic index foods, and all have comparable sugar profiles (refer Table 2). Samples 4 and 5 are borderline low/medium as the lower limit of the moderate GI range is 56; however, there is a large degree of individual variation in blood glucose response and hence GI values for the same test meal. Out of the ten individuals included in the analyses, three had a low GI response to honey sample 1 and five had a low GI response to honey samples 2, 3, 4, and 5 (not the same five individuals for all samples). High GI responses were only seen in 2–3 participants for each honey tested.

No statistical differences were observed between mean GI values for different honeys ($P > 0.5$).

4. Discussion

The World Health Organisation estimates that globally 346 million people have diabetes and that 44% of this is attributable to obesity and being overweight.[4,5] This dramatic increase in the rates of diabetes mellitus and obesity around the world indicate that studies which ascertain the GI index of commonly consumed foods are a necessary addition to the body of knowledge used in Public Health management of these co-morbidities.

As the results of this study show, there is little difference in the mean GI values of the Manuka honey samples, although there was a relatively high level of variability amongst participants. This is to be expected, and the degree of variability seen in the present study is comparable to that observed in other GI studies with honey.[7,14,19] The GI values reported in this study are comparable with the work of Perry et al. (2011) who reported that the one MGO 400+ Manuka honey sample tested had a GI of 65.[14] Further, these results are comparable to other honey samples. Arcot and Brand-Miller (2005)[7] reported GI values of between 32 and 75 for eight different Australian honeys, and four US honeys tested were in the range of 69–74.[9] The International Table published by Foster-Powel et al. (2002) indicates the GI to be 55 ± 5 as a mean of 11 values obtained from various honeys.[19]

Arcot & Brand-Miller (2005) stated that there were no significant correlations observed between GI and either total sugars, fructose level, organic acid content, pH or osmolality.[7] In addition, Ischayek & Kern (2006) detected no relationship between glycaemic index and the fructose-to-glucose ratio, indicating that small differences in fructose-to-glucose ratios do not substantially impact on honey glycaemic index.[9] The honey samples in this study all had sugar profiles that were very similar to each other, and this may have accounted for why the mean GI values of the five honeys also fell within a small range. There is insufficient data (specifically on GI variability) from this study to be able to draw conclusions about whether there is a correlation between the sugar profile and GI of Manuka honey, and it would be of interest to assess this in future studies.

Manuka honey has not specifically been evaluated in people with diabetes, but limited evidence suggests that honey, in general, may be better than glucose or sucrose for these individuals. One study, for example, reported that honey had a lower GI when compared with sucrose in patients with type 1 diabetes mellitus.[20] Further, in a small clinical study[21] plasma glucose levels were significantly lower after 1–3 h in diabetic patients who had consumed honey (20–75 g) than in those who had consumed equivalent amounts of glucose, sucrose or fructose. Further studies are needed to evaluate the effects of Manuka honey on GI in people with diabetes, although the lowered GI response compared to glucose suggest that it may also be a good choice of sweetener in these individuals. The results of the present study demonstrate that honeys can have lower effects on blood glucose levels than pure glucose, despite the fact that honey is more than 80% sugar by weight. There are some possible explanations why honey, although having a high carbohydrate content, has a low or moderate-low glycaemic index: (1) the glucose component of honey might be poorly absorbed from the gut[22]; (2) Palatinose or isomaltulose, a sugar present in honey, exhibits characteristics of delayed digestion and absorption[23,24] and (3) small amounts of fructose have been shown to increase hepatic glucose uptake and glycogen storage, as well as reducing peripheral glycaemia.[25] Furthermore, the unique physiochemical composition of honey contains other known and unknown substances that may play a role. For example, *in-vitro* studies with other honeys have shown some samples to have an insulin-mimetic effect.[26] Further, in a small clinical study in which 16 healthy individuals were given 60% aerosolized honey for 10 min,[27] mean blood glucose levels were shown to decrease by 22% after 30 min, and insulin levels were increased. Therefore, it is possible that the Manuka honeys tested might increase the plasma insulin levels in healthy volunteers; this should be measured in future studies.

The insulin regulating benefits of consuming a low GI diet for individuals with established diabetes are well known[12]; however, there are also strong links emerging between a high GI diet and coronary heart disease.[28] The global financial costs of managing these co-morbidities are in excess of hundreds of billions of dollars annually[4,5] suggesting that urgent action is required. The possible use of alternative, lower GI sweeteners, including honeys, is therefore one way in which this may be addressed.

Table 3
The GI values of the five honey products.

Sample		Mean GI (± SEM)	Range
1	WINPDW 60-11[a]	57 ± 7	32–84
2	BR15-11-154	59 ± 8	27–98
3	PORD3-11[b]	57 ± 10	18–112
4	MED WM38-10	55 ± 5	41–86
5	M75-11	54 ± 6	28–89

[a] $n = 8$ (One sample was not performed, and one calculated GI value was excluded as it lay more than 2 SD away from the mean).
[b] $n = 9$ (One calculated GI value was excluded as it lay more than 2 SD away from the mean).

Statement of authorship

Dr Chepulis and Ms Francis both contributed to the study design. Data collection was carried out by both authors (and additional

staff – see acknowledgements). Both authors contributed to the analysis and approved the final manuscript.

Conflicts of interest

There are no conflicts of interest to disclose.

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